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NOISE STUDY

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DATE:	April 12, 2010
SUBJECT:	**Cubist Facility Rooftop Noise Evaluation**

INTRODUCTION

Noise Control Engineering, Inc. (NCE) was retained by the Richmond Group to perform a rooftop noise evaluation for the Cubist facility vertical expansion at 65 Hayden Avenue in Lexington, Massachusetts. An overview of the analysis procedure, determination of the ambient background level, and the resulting noise levels due to rooftop equipment are detailed below.

NOISE REQUIREMENTS

Section §80-3 of the Town of Lexington Noise By-Law, reference [1] states that a condition of noise pollution results when:

> *a broadband sound source raises the noise level by 10 or more dBA above the ambient noise; or a tonal sound source raises its octave band noise level by three decibels or more above the adjacent octave band levels. These threshold levels are identical to those in the Massachusetts Division of Air Quality Control (DAQC) Policy 90-001 (2001).*

Consistent with the DAQC Policy, the sound levels to be used for this assessment will be the L_{90} sound levels, which represent the sound levels exceeded 90% of the time within a measurement period. The noise requirement for the Cubist project will be a measured L_{90} plus 10 dB, as determined in the next section.

BACKGROUND NOISE SURVEY

The background noise survey was conducted between September 24, 2009 and October 2, 2009. During the survey period no change in operations of the Cubist facility were made. The survey was performed using a RION, model NL-06 Type 2, logging sound level meter (SLM). The SLM was field calibrated prior to installation with a Larson Davis CAL 200

pistonphone at a level of 94 dB re 20 µPa at 1000 Hz. The SLM was laboratory calibrated to NIST traceable standards in the last 12 months. The SLM was located in the Northwestern corner of the Cubist property as shown in Figure 1. A photograph of the SLM on the site is shown in Figure 2.

The SLM was set to record, in 5 minute sampling periods, the 90% exceedance sound pressure level (L_{90}) and equivalent continuous sound pressure level (L_{EQ})[1]. These datasets are shown in Figure 3 for the entire measurement period. Since the Cubist operations will run 24 hours per day, the important period for establishing the background noise level is nighttime which is typically defined as 10pm to 7am for noise compliance matters. Figure 4 shows the same data as given in Figure 3, but only for the periods between 10pm and 7am each day.

First, to minimize the effect of any transient sounds on the nighttime data set, any L_{90} values that were greater than 10 dB above the minimum value were removed. Figure 5 shows the resulting nighttime data set. Second, for each night period (10pm to 7am) the average L_{90} value of a 108[2] samples were determined. Table 1 summarizes the nightly average L_{90} sound pressure levels. The overall average L_{90} sound pressure levels was found to be 48.2 dB(A) which rounded to the nearest decibel is 48 dB(A). Finally, the Town of Lexington and MADEP noise limit would be 48 dB(A) plus 10 dB or 58 dB(A). This limit would apply at the property line of the Cubist facility or the nearest inhabited residence.

TABLE 1: Summary of Nightly L90 Sound Pressure Levels

Day	Date	Nightly Average L90
Thursday	9/24/2009	47.3
Friday	9/25/2009	46.6
Saturday	9/26/2009	47.5
Sunday	9/27/2009	49.3
Monday	9/28/2009	49.4
Tuesday	9/29/2009	48.2
Wednesday	9/30/2009	48.7
Thursday	10/1/2009	48.7
Friday	10/2/2009	47.9
Average		**48.2**

NOISE CONTROL FEATURES

The Cubist vertical expansion project has numerous features that minimize noise to the environment. First, the HVAC engineers have selected equipment that has generally lower ñsourceò sound levels. For example, the strobic fans being used for the Lab Exhaust have

[1] This value is not required for the compliance measurement, but is provided as a reference.

[2] 9 hours of 5 minute samples (9 x 12 = 108 samples).

built in silencers and a quiet design which significantly reduce the noise to environment. NCE has directly compared the selected strobic fans to other vendor fans with equal or greater flow rate, finding that the selected strobic fans have much lower sound levels. Second, four of the largest air handling units (AHU) will be enclosed in a penthouse where only the louver openings will allow transmission of sound to the environment. These air handling units will also have intake air silencers installed within the unit housing. Finally, the rest of the rooftop mechanical equipment will be blocked by a visual screen which will act as a noise barrier for all but the Cooling Towers. Other specific features or situations which mitigate sound to the environment are discussed in the Evaluation section below.

EVALUATION

To perform the rooftop noise analysis, NCE took sound pressure levels (SPL) from the existing rooftop equipment, measured by NCE in September 2009, and compiled the measured levels with manufacturer noise data for the proposed new equipment. The total number of sources includes 18 operating units. Table 2 summarizes the sound pressure levels and sound power levels by equipment type that were used in the analysis.

TABLE 2: Source Sound Pressure (Lp) and Sound Power (Lw) Levels for Rooftop Mechanical Equipment by Type

Equipment Name	Model	Data*	31.5	63	125	250	500	1000	2000	4000	8000		dB(A)
Cooling Tower	CT-1 Series 3-	Lw	-	98	97	97	93	88	82	77	74		-
CH - 1,2,3	AGS210CS1CH	Lp @ 3ft	*64*	73	73	74	74	73	70	64	59		77
MUA - 4	RAH077C	Lp @ 3ft	*74*	73	71	62	59	57	53	49	43		63
MUA - 2	RAH077C	Lp @ 3ft	*70*	73	72	63	59	58	53	48	43		63
EF - 1 ABCDEFG	TS4L600C12	Lp @ 10ft	-	81	81	80	77	74	71	72	64		80
MUA 1B	RPS050C	Lp @ 3ft	*70*	73	74	62	59	57	54	51	49		64
MUA 1A	RAH077C	Lp @ 3ft	*70*	73	74	62	59	57	54	51	49		64
EF - 2 ABC	TS1L150B18	Lp @ 10ft	*67*	82	72	68	64	64	60	59	56		69
MUA - 3	RAH077C	Lp @ 3ft	*72*	70	69	63	59	54	53	49	42		62
AHUs	-	Lw	-	95	92	88	85	85	82	78	71	Lw	-

* Lp denotes a sound pressure level at a specific distance from the equipment. Lw denotes a sound power level which does not require specification of measurement distance.

The SPL values in Table 2 were projected to the facilityôs property line. Six evaluation points were selected in the Western and Northern directions since the surrounding woodlands are considered noise sensitive areas. Figure 6 indicates the positions where the predicted noise levels were calculated.

Factors contributing to sound source attenuation at the property line include, spherical spreading without atmospheric absorption which predicts how sound falls off with distance, attenuation due to the directivity of the sound source, and insertion loss due to the rooftop

screen which acts as a noise barrier for certain equipment. Although the rooftop screen provides some attenuation, its functionality as a barrier is reduced due to the gap between the roof deck and base of the screen. No barrier effect was included for the Cooling Tower in western direction. To obtain proper airflow, louvers will be installed in the screen at this location. With louvers and the aforementioned undercut, the screen is acoustically transparent at the Cooling Towerôs western face.

The roof penthouse contains three air handling units which experience some attenuation due to this enclosure. However, intake louvers will also be installed on the western side of the penthouse, allowing the interior equipment to contribute to the overall exterior noise levels. The sound radiating from the penthouse louvers is a function of the intake exhaust noise level for the AHUs.

Emergency backup generators will also be located at the Cubist facility and were considered in the noise analysis. It should be noted that these generators run only once a month for maintenance and otherwise only under emergency conditions.

RESULTS

Table 3 contains the overall noise levels for each point along the property line due to the rooftop equipment alone. A negative value indicates that the noise level is below the noise limitation. The MADEP noise requirement, as stated above, is 58 dB(A). For all directions the limit is being met by at least 9 dB.

TABLE 3: Predicted Sound Pressure Levels for Rooftop only

Point	SIDE OF BUILDING	SPL dB(A)	Δ from Limit
1	South West	46	-12
2	West	48	-10
3	North West	49	-9
4	North West	42	-16
5	North West	46	-12
6	North East	44	-14

In order to determine which sets of equipment control the overall noise level, Table 4 summarizes the individual equipment noise contribution at each point. Both the Air Handling Units in the penthouse and cooling tower are the controlling elements since they receive no benefit from the screen.

TABLE 4: Individual Equipment Sound Pressure Levels at the Property Line

		SPL (dBA) at Property Line Points					
Equipment		**1**	**2**	**3**	**4**	**5**	**6**
Cooling Tower		40	41	45	33	37	35
CH - 1,2,3		25	26	29	25	29	27
MUA - 4		10	11	13	10	14	13
MUA - 2		11	12	14	10	15	14
EF - 1 ABCDEFG		35	36	38	32	36	35
MUA 1B		12	12	10	8	11	10
MUA 1A		14	13	9	8	11	10
EF - 2 ABC		31	31	28	27	30	29
MUA - 3		11	11	7	6	9	8
AHUs		45	46	47	41	44	43
Total dB(A)		**46**	**48**	**49**	**42**	**46**	**44**
Level To Limit		-12	-10	-9	-16	-12	-14

Table 5 contains the sound pressure levels due to the background generators for each direction as well the overall predicted noise levels including the rooftop equipment. Again, the overall noise levels are below the MADEP noise limit by at least 7dB.

TABLE 5: Predicted Sound Pressure Levels for Rooftop and Generators

Point	SIDE OF BUILDING	Generator SPL dB(A)	Total SPL dB(A)	Δ from Limit
1	South West	41	47	-11
2	West	39	48	-10
3	North West	46	51	-7
4	North West	40	44	-14
5	North West	45	48	-10
6	North East	45	48	-10

CONCLUSION

The combination of all rooftop equipment, including that contained in the penthouse, complies with the MADEP noise limit. After conducting a background noise survey, NCE determined the background noise level to be 48 dB(A). As per the MADEP guidelines, the rooftop equipment shall not raise the background noise level 10 dB above the ambient to 58 dB(A). In the noise sensitive directions, the predicted noise level complies with this limit for all selected points along the property line located to the North and West of the building. When the generators are running the overall noise levels are not significantly increased and still comply with the MADEP noise requirement.

FIGURE 1: Survey location for the background noise measurements at Cubist.

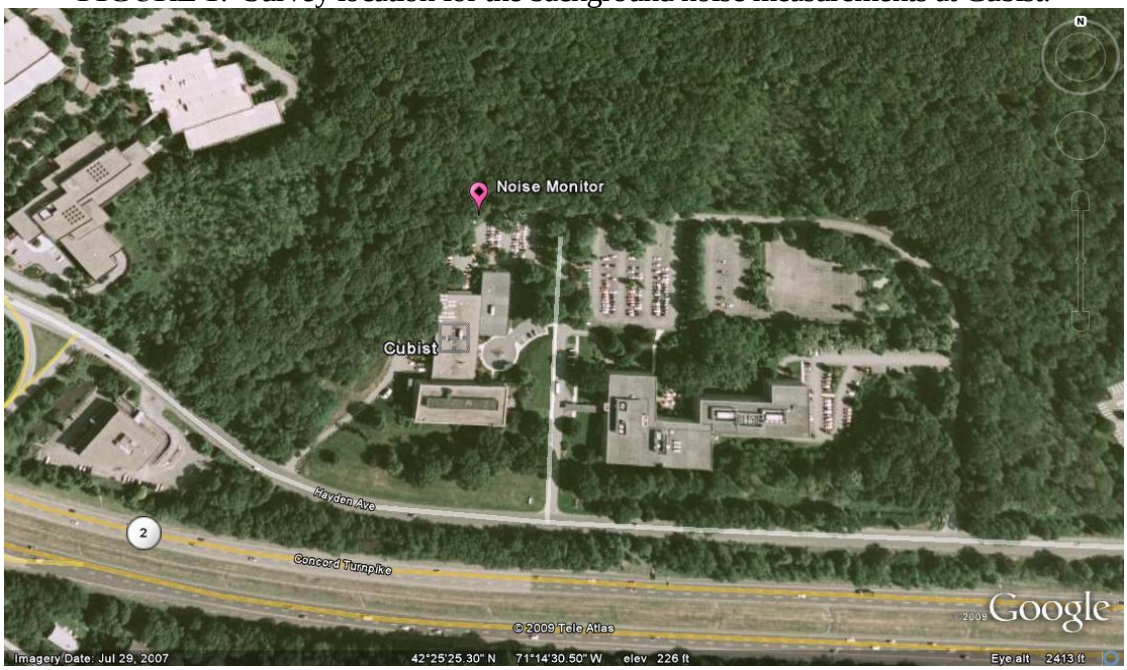

FIGURE 2: SLM as installed at the Cubist Site.

FIGURE 3: Background noise data for entire measurement period.

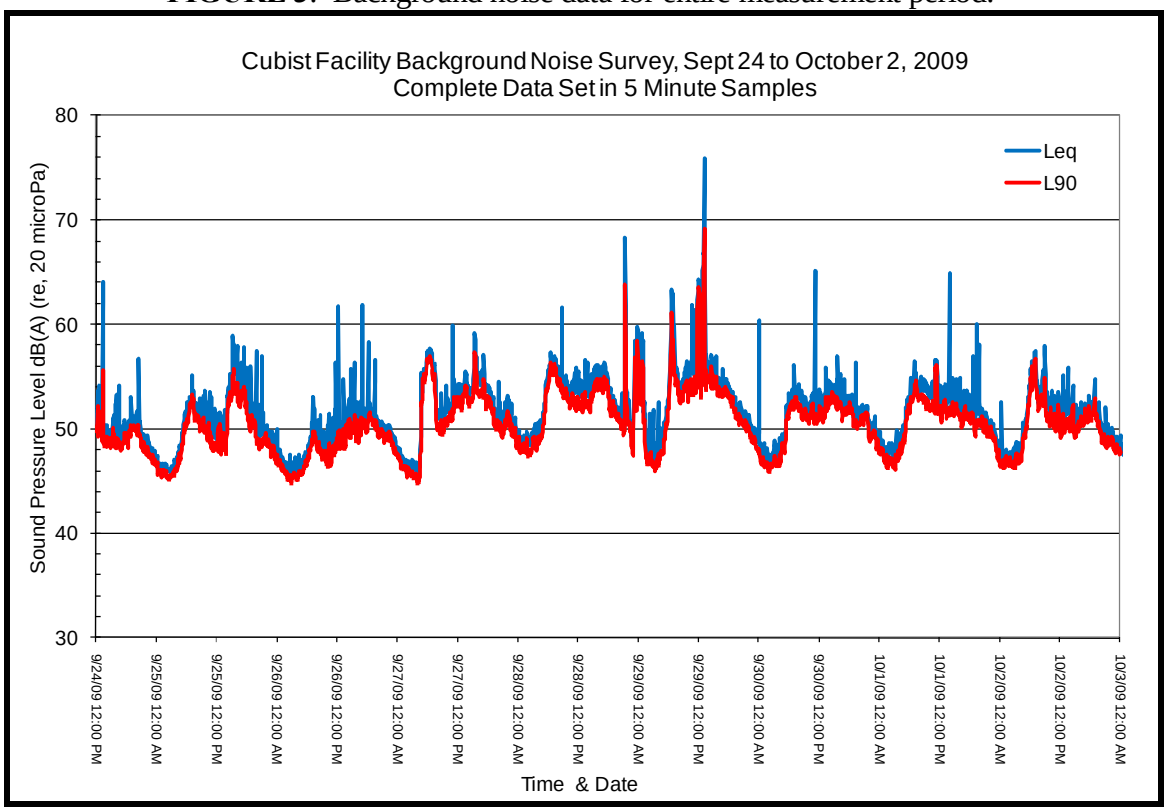

FIGURE 4: Background noise data for nighttime (10pm to 7am).

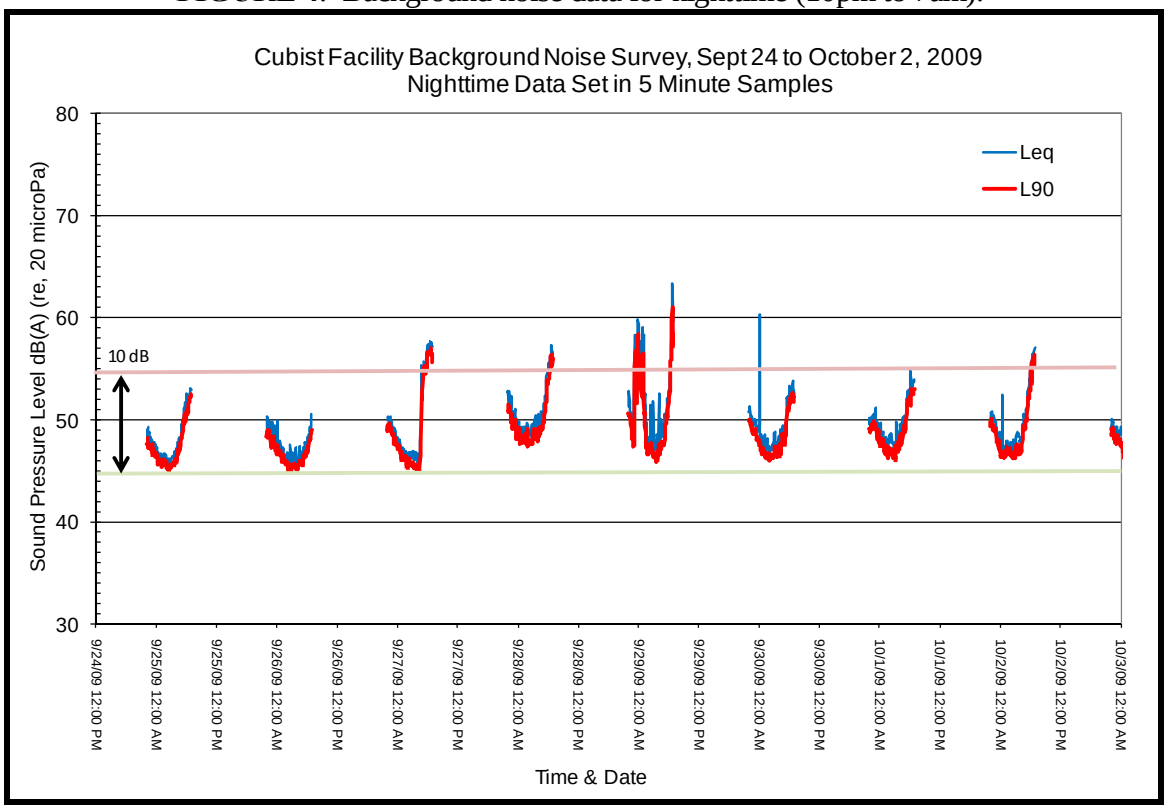

FIGURE 5: Background noise data for nighttime (10pm to 7am) with > 10 dB excursions removed. The average background sound pressure level and MADEP Limit are shown.

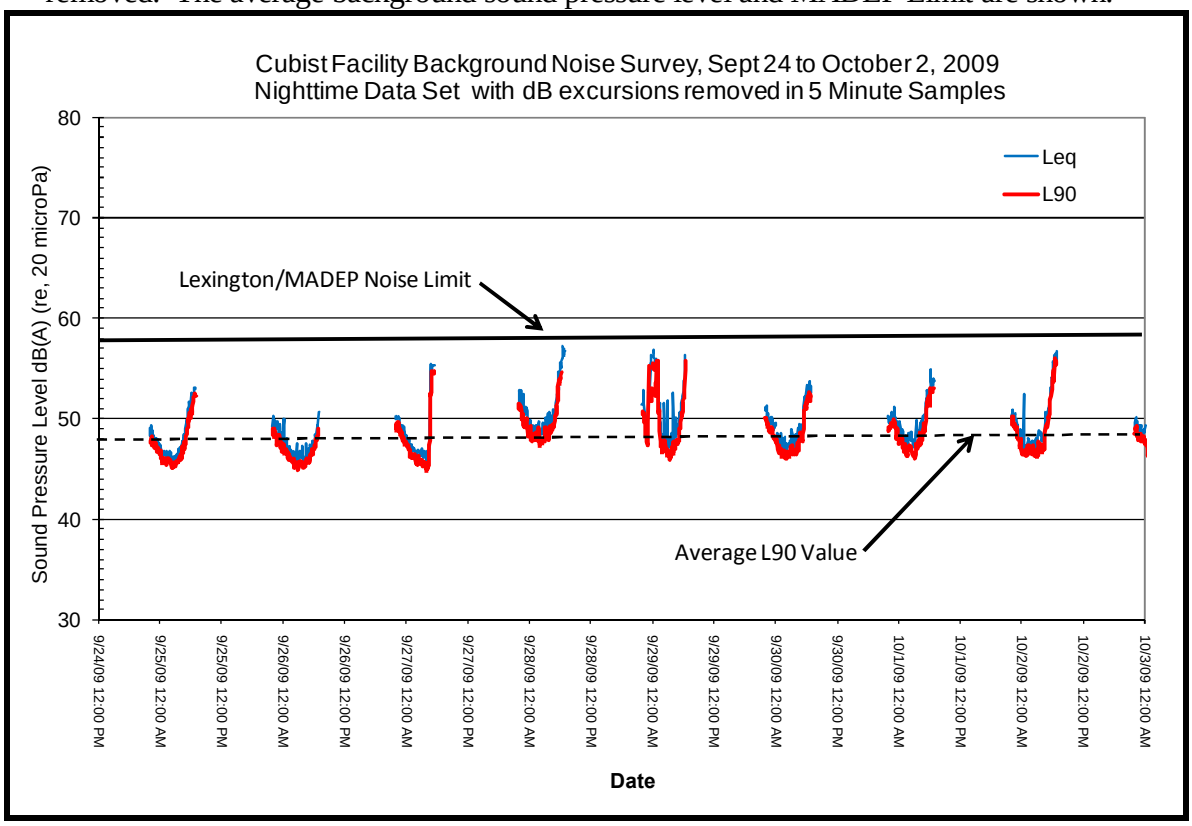

FIGURE 6: Locations of predicted noise level at the property line